Time and Size at Release Experiment: Four Releases of Three Size Categories of Juvenile Chinook Salmon from the Quinsam Hatchery in the Spring of 1982

H. T. Bilton, A. S. Coburn, and R. B. Morley

Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

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Canadian Data Report of

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May 1983

TIME AND SIZE AT RELEASE EXPERIMENT: FOUR RELEASES OF THREE SIZE CATEGORIES OF JUVENILE CHINOOK SALMON FROM THE QUINSAM HATCHERY IN THE SPRING OF 1982

by

H. T. Bilton, A. S. Coburn, and R. B. Morley

Department of Fisheries and Oceans

Fisheries Research Branch

Pacific Biological Station

Nanaimo, British Columbia V9R 5K6

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ABSTRACT

Bilton, H. T., A. S. Coburn, and R. B. Morley. 1983. Time and size at release experiment: four releases of three size groups of juvenile chinook salmon from the Quinsam Hatchery in the Spring of 1982. Can. Data Rep. Fish. Aquat. Sci. No. 397: iv + 18 p.

This report provides, in readily accessible form, background information required to assess the results of an experiment in progress at the Quinsam River production hatchery, Campbell River, B.C. The experiment is designed to measure the effects of time and size at release of juvenile Chinook salmon (Oncorhynchus tshawytscha) on their subsequent survival, growth, distribution, and age at maturity. In the spring of 1982 four releases (May 5, May 26, June 16, and July 7) of juvenile chinook salmon, each comprised of three size groups, were released from the Quinsam River hatchery, representing a combined total of 315,986 marked and tagged fish. Prior to each release, samples of smolts were obtained for examination for disease, proximate analysis, and sea water challenge tests. Specific information on lengths, weights, sex composition, health, and ability of released fish to adapt to sea water is given.

Key words: Quinsam, chinook, data, release size, release time.

RÉSUMÉ

Bilton, H. T., A. S. Coburn, and R. B. Morley. 1983. Time and size at release experiment: four releases of three size groups of juvenile chinook salmon from the Quinsam Hatchery in the Spring of 1982. Can. Data Rep. Fish. Aquat. Sci. No. 397: iv + 18 p.

Le présent rapport fournit, dans une forme facilement accessible, les données fondamentales nécessaires à l'évaluation des résultats d'une expérience présentement en cours à la pisciculture de la rivière Quinsam, à Campbell River (C.-B.). Cette expérience vise à quantifier l'incidence de la taille des saumons quinnats (Oncorhynchus tshawytscha) juvéniles mis en liberté, et du moment choisi pour ce faire, sur leur survie ultérieure, leur croissance, leur répartition et leur âge à la maturité. Au printemps de 1982, quatre lâchers (5 mai, 26 mai, 16 juin et 7 juillet) de saumons quinnats juvéniles, chacun comprenant trois classes de longueur, ont été effectués à la pisciculture de la rivière Quinsam. Au total, 315 986 poissons étiquetés et marqués ont été mis en liberté. Avant chaque lâcher, des échantillons de saumoneaux ont été obtenus pour l'examen pathologique, l'analyse immédiate et des tests d'acclimatation à l'eau de mer. Le rapport contient des données précises sur la longueur, le poids, la répartition des sexes, l'état de santé des poissons relâchés et leur capacité à s'acclimater à l'eau de mer.

Mots-clés: Quinsam, quinnat, données, taille au lâcher, moment du lâcher.

INTRODUCTION

The purpose of this report is to provide, in readily accessible form, background information required in a current experiment on the effects of time and size at release of juvenile Quinsam River chinook salmon (Oncorhynchus tshawytscha) on their subsequent survival, growth, distribution and age at maturity. The report has been divided into four major sections: the first deals with the smolt releases; the second with disease; the third with sea-water challenge tests; and the fourth with number of tagged juveniles recovered by the Coastal Habitat group in a study of the Campbell River estuary and adjacent waters.

SECTION 1. SMOLT RELEASES

MATERIALS AND METHODS

A. Donor stock and rearing

A part of the production stock of 1981 brood Quinsam hatchery juvenile chinook were used for the experiment. Fish assigned to the experiment were reared separately from the production fish using normal hatchery water supply, in 2 Burrow's ponds at production densities. Fish were fed Oregon moist pellets (OMP) according to hatchery feeding schedule. It should be noted there were insufficient fish in the two ponds for the last release. Hence, some fish from a production pond were used in addition to what remained of the experimental groups.

B. Experimental Design

The object of the experiment was to release three sizes of juvenile chinooks on each of four dates. Size groups were achieved by grading the population of fish in each pond into small, medium, and large size length categories. Each size group was replicated three times. Thus there were nine groups planned for each release, making a total of 36 groups for all four releases. The design was as shown below.

Release date and number of fish

Size Category	May 5	May 26	June 16	July 7
Small	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
Total	30,000	30,000	30,000	30,000
Medium	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
Total	30,000	30,000	30,000	30,000
Large	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
Total	30,000	30,000	30,000	30,000
Grand Total	90,000	90,000	90,000	90,000

C. Nose-Tagging and Marking

All fish were tagged and marked during the period mid-April to mid-June, 1982. On an alternating basis for each release, a portion of the fish from one of the two stock ponds were removed, tagged, and transferred into a release pond: e.g., for release 1 fish from pond A were used; for release 2 fish from pond B were used, and so on. Just prior to each tagging session, a sample of 1,000 fish was taken from the stock pond. These were anesthetized, measured for length, and returned to the pond. Length-frequency curves derived from these data were used to determine the size categories for marking. Arbitrarily, it was decided that fish with lengths falling within the 5% tails of the curve would be rejected to remove out-riders and that the remaining 90% would be divided into three equal proportions, classified as small, medium and large.

Once size categories were determined, marking and tagging of the fish was initiated. Fish were first anesthetized and graded to size category. The adipose fin was then removed and the appropriately coded binary magnetic wire nose tag applied. Tagged fish were then transferred to the release pond. It should be noted that because of the rapid growth of the

fish at this time of the year, the limits delineating each size category had to be moved upwards several millimeters every two to three days throughout each of the four tagging sessions (a session lasted 10-12 days).

Due to a shortage of fish, only 2 replicates of each size category were tagged for the final release (as opposed to 3 replicates for all other releases).

D. Release

Approximately 900 tagged fish were randomly removed from the release pond on the day of each release. These fish were killed and retained for subsequent examination for tag code, length, weight, and sex. A further 90 fish (30 small, 30 medium, and 30 large) were killed and frozen for subsequent proximate analysis by D. Higgs (results of proximate analysis are not reported here). Before each release a sample of 100 fish were examined for disease by the Diagnostic Services section (G. Hoskins). In addition, samples of approximately 36 live fish (12 small, 12 medium, 12 large) were removed just prior to release and tested by C. Clarke for their ability to adapt to sea water as measured by blood sodium levels after 24 h exposure to sea water (Clarke and Blackburn 1977).

Each release of fish began at approximately 1800 hours by removal of stop logs from the end of the pond leading directly to a channel to the river. Fish were released on May 5, May 26, June 16, and July 7, 1982.

RESULTS

The numbers of tagged fish released on each date are given by tag-code in Tables 1 - 4. Also given in Tables 1 - 4 are estimates (based on release samples) of mean lengths and weights of fish by sex in each of the groups. An estimated total of 327,058 marked fish were released, of which 315,986 were estimated to have a tag (based on incidence of marked fish without tags in the release samples). Estimated tag loss by release and size category is given in Table 5. In three of the four releases there were highly significant negative correlations between percent tag loss and mean length at release, e.g., second release, $r = -0.91$, $n = 9$, $P = <0.001$; third release, $r = -0.94$, $n = 9$, $p<.001$; fourth release, $r = -0.97$, $n = 6$, $P <.001$. Among fish of the first release there was a positive but non significant correlation, $r = 0.44$, $n = 9$, $P>.05$. When the groups from all releases are combined a significant negative correlation resulted, $r = -0.37$, $n = 33$, $p<.05$. Comparison of the percent tag loss with the standard deviation at release indicated significant positive correlations between these two variables for all but one release, e.g., second release, $r = 0.89$, $n = 9$, $P<.001$; third release, $r = 0.77$, $n = 9$, $P<.02$; fourth release, $r = 0.87$, $n = 6$, $P<.01$. Among fish of the first release there was a positive but non significant correlation, $r = 0.31$, $n = 9$, $P>.05$. When the groups from all releases are combined and compared a highly significant positive correlation

results, r = .65, n=33, P<.001. These data indicate that within three of the release groups, size of fish and tag loss are inversely related, with the tag loss decreasing with increased size of fish. Since this occurred in three of the releases even though the fish had grown over time it does not seem to be an effect of size alone. For example, the first group of small category fish from release one, averaged 56.92 mm and tag loss of 6.5%; for release two 77.37 mm and 6.98%; for release three 89.70 mm and 6.5%; and for release four 95.51 mm and 7.40% (Table 5). The positive correlation between tag loss and standard deviation suggests the problem may result from variability in size of the group being tagged. Variability was greatest for small category fish; among fish of each release there was a negative correlation between the mean and the standard deviation (release one, r = -0.69, n = 9,; release two, r = -0.69, n = 9; release three, r = -0.66, n = 9; and release four, r = -0.73, n = 6). The correlations were significant at the 5% level among fish from the first three releases and of borderline significance among those of the fourth release (P>.05). It is possible the head molds used for tagging the small fish were not adequate to cover the range of sizes encountered, resulting in improper implantation of the tags and greater tag loss for fish of this size category.

Deviations from a 50:50 sex ratio in the samples from each release group were tested using the 50% probability test (Langley 1979). In eight of the 33 groups there were significantly more males than females (P<0.05). These groups were: May 5 release, tag-codes 8-21-19, 8-21-21, 8-21-23, 8-21-25, 8-21-26, 8-21-27; July 7 release, tag-codes 8-21-52, 8-21-53.

Examination of the sex ratios of fish in the total samples from each release (all groups combined) indicates that for each release there were significantly more males than females (P<0.05).

Comparison of the sex ratios of fish in samples from the three size categories from each release (replicates combined) using chi-square (Langley 1979) indicated no differences (P>0.05) in the proportions of males and females between size categories for the first three releases. However, for samples from the fourth release, a borderline significant difference was observed (χ^2 = 6.00, d.f. 2, P<0.05) with a higher proportion of males in the large category than in the other categories.

SECTION 2. DISEASE

This section was provided by the Diagnostic Services and summarizes the methods and results of disease examination of fish from each of the four releases.

The following samples of tagged chinook smolts were randomly selected from the release ponds on dates indicated.

Case No.	Release Date	Collection Date	Number examined	
			Random	Moribund
82-149	May 5/82	May 5/82	100	10
82-183	May 26/82	May 25/82	100	10
82-224	June 16/82	June 15/82	100	10
82-254	July 7/82	July 6/82	100	5

METHODS

A. Random Samples

(1) 100 fish were randomly selected by dip net from different areas in each pond.

(2) Fish were examined internally and externally for gross signs of pathology and infectious disease.

(3) Kidney tissue was streaked aseptically onto Tryptic Soy Agar (TSA) for the detection of bacterial pathogens.

(4) Gram stained kidney tissue was examined for the detection of bacterial and parasitic agents.

(5) As a general indicator of health, microhematocrit values were collected on the first 25 fish in each sample.

(6) Liver and kidney tissue was collected for histological examination of the first 25 fish in each sample.

B. Moribund Samples

(1) If available, moribund or fresh dead fish (to a maximum of 10) were sampled from each pond.

(2) The sampling procedure was the same as for random fish, but omitting the collection of microhematocrit values and histological samples.

(3) In random samples a very low incidence of infectious disease can often not be detected, while examinations of moribund and/or fresh dead fish may show the presence of a bacterial pathogen more readily.

RESULTS

No abnormalities or pathogens were found in any of these fish with the exception of 2 fish from the first sample (May 5/82) which showed external fungus. The microhematocrit values were: 5 May - average 36.8%, range 31 - 42%; 26 May - average 40.6%, range 33 - 47%; 16 June - average 40.1%, range 17 - 47%; 7 July - average 41.2%, range 30 - 49%.

Histology: Liver and anterior kidney were examined from the first 25 fish in each group. All kidney sections were normal. Liver sections in 25% of the chinook showed some slight to moderate vacuolation.

CONCLUSIONS

(1) Many fish had pale livers. However this, as well as the degree of liver vacuolation seen in histology, can be considered to be within the normal range for hatchery-raised fish.

(2) In comparison to the normal range of microhematocrit values which lies between 35 - 45%, some of the observed values were low (e.g., 17%). However the average values were in the normal range.

(3) No eye damage or opacity was seen in any of these fish.

SECTION 3. SEAWATER CHALLENGE TESTS

This section was provided by C. Clarke. Tests were performed on tagged fish from May 6 to July 8 (Table 6). At the time of the first release in early May, the medium and large size groups showed good seawater adaptability as evidenced by relatively low blood sodiums after 24 h exposure to seawater. However, by late May and early June all groups showed only mediocre adaptability. Overall adaptability was poorest June 7 but by the time of the third release was much improved for all size groups and remained so for the last sampling July 8.

SECTION 4. RECOVERIES IN ESTUARY SAMPLING

This section was provided by the Coastal Habitat Group (C. D. Levings). The following table lists by tag code, the numbers of chinook juveniles from the various size and time groups released in the spring of 1982 that were subsequently recovered in the Campbell River estuary and adjacent waters up until November 10, 1982. Sampling is still being conducted, hence there may be additional recoveries.

Tag code	Number recovered Period May 10-June 17/82	Period June 19-Nov 10/82	Total
8-21-19	22	18	40
8-21-20	22	22	44
9-21-21	29	11	40
8-21-22	33	12	45
8-21-23	36	19	55
8-21-24	36	14	50
8-21-25	46	7	53
8-21-26	51	6	57
8-21-27	51	2	53
8-21-28	20	15	35
8-21-29	21	16	37
8-21-30	13	18	31
8-21-31	23	11	34
8-21-32	23	14	37
8-21-33	31	15	46
8-21-34	13	5	18
8-21-35	22	8	30
8-21-36	18	9	27
8-21-37	9	35	44
8-21-38	7	36	43
8-21-39	17	25	42
8-21-40	4	15	19
8-21-41	7	20	27
8-21-42	10	22	32
8-21-43	11	16	27
8-21-44	5	22	27
8-21-45	4	16	20
8-21-46	-	66	66
8-21-47	-	61	61
8-21-49	-	65	65
8-21-50	-	43	43
8-21-52	-	59	59
8-21-53	-	46	46
Total	584	769	1,353

ACKNOWLEDGMENTS

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Table 1. Numbers of tagged chinook smolts in the nine groups released at Quinsam hatchery on May 5, 1982. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag[b] code	Number tagged fish released	Size group	Length (mm)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-19	6,740	small	56.96	4.53	28	56.85	2.91	13	56.92	4.05	41	55.65-58.20	7.12	+	56.00
8-21-20	9,215	small	59.56	3.48	52	58.76	3.49	33	59.25	3.48	85	58.49-59.99	5.88	-	60.00
8-21-21	8,782	small	58.04	3.63	53	58.37	3.01	27	58.15	3.42	80	57.39-58.91	5.87	-	58.00
8-21-22	9,761	medium	60.82	2.82	44	62.03	3.20	30	61.31	3.02	74	60.61-62.01	4.92	-	62.00
8-21-23	10,070	medium	63.38	2.88	69	63.30	2.73	43	63.35	2.81	112	62.82-63.87	4.44	-	63.00
8-21-24	10,108	medium	65.67	2.44	72	65.58	2.64	50	65.63	2.51	122	65.18-66.08	3.83	-	65.50
8-21-25	9,539	large	68.17	3.11	76	67.41	3.52	32	67.94	3.24	108	67.33-68.56	4.77	-	68.00
8-21-26	9,754	large	67.40	2.99	68	67.52	2.59	46	67.45	2.82	114	66.92-67.97	4.18	+	67.00
8-21-27	9,622	large	69.65	3.16	71	69.45	2.75	42	69.57	3.00	113	69.01-70.13	4.32	-	70.00
Total	83,591				533			316			849				

Table 1 (cont'd)

Tag[b] code	Number tagged fish released	Size group	Weight (g)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-19	6,740	small	2.17	0.63	28	2.13	0.33	13	2.16	0.55	41	1.98-2.33	25.56	+*	2.13
8-21-20	9,215	small	2.43	0.43	52	2.35	0.37	33	2.39	0.41	85	2.31-2.48	16.98	-	2.41
8-21-21	8,782	small	2.17	0.45	53	2.20	0.30	27	2.18	0.40	80	2.09-2.27	18.53	+	2.24
8-21-22	9,761	medium	2.65	0.41	44	2.78	0.39	30	2.70	0.40	74	2.61-2.80	14.97	-	2.65
8-21-23	10,070	medium	2.94	0.40	69	2.90	0.43	43	2.92	0.41	112	2.85-3.00	13.98	+*	2.91
8-21-24	10,108	medium	3.19	0.37	72	3.18	0.39	50	3.18	0.38	122	3.12-3.25	11.86	+	3.19
8-21-25	9,539	large	3.74	0.54	76	3.64	0.53	32	3.71	0.54	108	3.61-3.81	14.53	+	3.67
8-21-26	9,754	large	3.69	0.53	68	3.63	0.46	46	3.67	0.50	114	3.57-3.76	13.65	+*	3.58
8-21-27	9,622	large	3.85	0.50	71	3.85	0.59	42	3.85	0.54	113	3.75-3.95	13.91	+	3.83
Total	83,591				533			316			849				

[a]Note: Skewed right = +; skewed left = -; *significant at .05 level.

[b]the first number indicates agency, the second data 1, the third data 2.

Table 2. Number of tagged chinook smolts in the nine groups released at Quinsam hatchery on May 26, 1982.Mean lengths and weights by sex, of smolts sampled at release are given.

Tag[b] code	Number tagged fish released	Size group	Length (mm)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-28	9,434	small	76.92	4.41	37	77.80	4.71	40	77.37	4.56	77	76.34-78.41	5.89	+	78.00
8-21-29	9,590	small	76.62	4.77	55	77.49	3.52	43	77.00	4.27	98	76.14-77.86	5.55	-*	78.00
8-21-30	9,072	small	78.88	6.44	33	78.61	5.45	28	78.75	5.96	61	77.23-80.28	7.57	-	79.00
8-21-31	10,184	medium	84.67	2.89	61	84.31	3.79	48	84.51	3.31	109	83.88-85.14	3.91	+	85.00
8-21-32	10,302	medium	84.40	2.81	69	84.72	2.97	58	84.55	2.87	127	84.05-85.06	3.40	-	85.00
8-21-33	9,776	medium	84.79	2.77	44	84.43	1.88	46	84.61	2.35	90	84.12-85.10	2.78	-	85.00
8-21-34	10,205	large	89.73	3.04	56	90.32	3.40	44	89.99	3.20	100	89.35-90.62	3.56	+	90.00
8-21-35	10,394	large	89.27	2.98	52	89.02	3.33	44	89.16	3.13	96	88.52-89.79	3.51	-	89.00
8-21-36	10,169	large	90.54	2.83	66	89.37	3.75	46	90.06	3.28	112	89.45-90.68	3.64	-*	90.00
Total	89,126				473			397			870				

Table 2 (cont'd)

Tag[b] code	Number tagged fish released	Size group	Weight (g)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-28	9,434	small	5.19	0.85	37	5.44	0.89	40	5.32	0.88	77	5.12-5.52	16.51	+	5.35
8-21-29	9,590	small	5.13	0.94	55	5.26	0.73	43	5.18	0.85	98	5.01-5.36	16.49	-*	5.26
8-21-30	9,072	small	5.52	1.49	33	5.39	1.07	28	5.46	1.30	61	5.12-5.79	23.85	+*	5.45
8-21-31	10,184	medium	6.97	0.76	61	6.83	0.91	48	6.91	0.83	109	6.75-7.07	12.00	+	6.89
8-21-32	10,302	medium	6.82	0.69	69	6.95	0.78	58	6.88	0.74	127	6.75-7.01	10.72	+	6.78
8-21-33	9,776	medium	6.79	0.61	44	6.60	0.57	46	6.70	0.59	90	6.57-6.82	8.84	+*	6.68
8-21-34	10,205	large	8.42	1.03	56	8.39	1.03	44	8.41	1.02	100	8.20-8.61	12.18	+	8.26
8-21-35	10,394	large	8.03	0.76	52	8.17	0.86	44	8.09	0.81	96	7.93-8.25	9.96	+	8.01
8-21-36	10,169	large	8.23	0.81	66	8.08	0.96	46	8.17	0.87	112	8.01-7.88	10.70	-*	8.08
Total	89,126				473			397			870				

[a]Note: Skewed right = +; skewed left = -; *Significant at .05 level.

[b]the first number indicates agency, the second data 1, the third data 2.

Table 3. Numbers of tagged chinook smolts in the nine groups released at Quinsam hatchery on June 16, 1982. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag[b] code	Number tagged fish released	Size group	Length (mm)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-37	9,478	small	88.98	4.89	48	90.76	3.39	33	89.70	4.41	81	88.73-90.68	4.91	+	90.00
8-21-38	9,763	small	87.42	3.65	47	87.52	3.58	42	87.47	3.60	89	86.71-88.23	4.11	+	87.00
8-21-39	9,400	small	86.12	4.05	50	87.85	4.74	41	86.90	4.43	91	85.98-87.82	5.10	+*	87.00
8-21-40	10,022	medium	96.24	3.38	53	96.26	2.65	38	96.25	3.08	91	95.61-96.89	3.20	-	96.00
8-21-41	10,417	medium	94.46	3.37	58	94.36	3.37	52	94.42	3.35	110	93.78-95.05	3.55	+	95.00
8-21-42	9,739	medium	92.93	3.08	44	92.17	2.38	36	92.59	2.80	80	91.96-93.21	3.02	+*	92.00
8-21-43	10,602	large	99.37	3.43	58	98.66	3.50	50	99.05	3.46	108	98.38-99.71	3.50	-*	99.00
8-21-44	10,119	large	102.07	2.66	45	100.96	3.45	45	101.51	3.11	90	100.86-102.16	3.07	-*	102.00
8-21-45	10,059	large	97.95	3.32	56	97.65	2.55	49	97.81	2.97	105	97.23-98.38	3.04	+	97.00
Total	89,599				459			386			845				

Table 3 (cont'd)

Tag[b] code	Number tagged fish released	Size group	Weight (g)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-37	9,478	small	8.21	1.48	48	8.74	1.19	33	8.43	1.39	81	8.12-8.73	16.45	+*	8.48
8-21-38	9,763	small	7.76	1.04	47	7.75	1.08	42	7.76	1.05	89	7.54-7.98	13.55	+	7.67
8-21-39	9,400	small	7.17	1.01	50	7.51	1.30	41	7.32	1.15	91	7.08-7.56	15.78	+*	7.24
8-21-40	10,022	medium	10.43	1.00	53	10.27	0.87	38	10.36	0.94	91	10.17-10.56	9.12	-	10.42
8-21-41	10,417	medium	9.56	0.89	58	9.67	1.13	52	9.61	1.01	110	9.42-9.80	10.47	-	9.62
8-21-42	9,739	medium	9.06	0.98	44	8.63	0.65	36	8.87	0.87	80	8.68-9.06	9.79	+*	8.84
8-21-43	10,602	large	11.24	1.18	58	11.12	1.30	50	11.19	1.23	108	10.95-11.42	11.01	-	11.13
8-21-44	10,119	large	12.42	1.16	45	12.10	1.33	45	12.26	1.25	90	12.00-12.52	10.20	-*	12.27
8-21-45	10.059	large	10.58	1.14	56	10.45	0.83	49	10.52	1.01	105	10.33-10.72	9.58	+*	10.33
Total	89,599				459			386			845				

[a]Note: Skewed right = +; skewed left = -; *significant at .05 level

[b]the first number indicates agency, the second data 1, the third data 2.

Table 4. Numbers of tagged chinook smolts in the six groups released at Quinsam hatchery on July 7, 1982. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag[b] code	Number tagged fish released	Size group	Length (mm)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-46	9,074	small	95.36	5.10	53	95.69	4.94	45	95.51	5.00	98	94.51-96.51	5.24	-*	96.00
8-21-47	9,249	small	94.28	6.38	39	94.35	5.04	45	94.32	5.67	84	93.09-95.55	6.01	-	95.00
8-21-49	9,578	medium	104.25	3.30	84	104.01	2.86	82	104.31	3.09	166	103.66-104.60	2.96	+	105.00
8-21-50	6,859	medium	102.55	3.69	58	102.76	3.14	47	102.65	3.44	105	101.98-103.31	3.35	-	103.00
8-21-52	9,704	large	111.00	4.03	119	110.43	4.41	72	110.78	4.17	191	110.19-111.38	3.77	+	111.00
8-21-53	9,206	large	109.59	2.75	76	109.45	3.76	51	109.53	3.18	127	108.98-110.09	3.26	-*	110.00
Total	53,670				429			342			771				

Table 4 (cont'd)

Tag[b] code	Number tagged fish released	Size group	Weight (g)									95% confidence limits	Coeff. variation	Skewness[a]	Median
			Male			Female			Male and Female						
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N				
8-21-46	9,074	small	10.23	1.68	53	10.23	1.62	45	10.23	1.65	98	9.90-10.56	16.11	-	10.36
8-21-47	9,249	small	9.67	1.77	39	9.87	1.48	45	9.78	1.62	84	9.43-10.13	16.55	-	9.99
8-21-49	9,578	medium	13.33	1.26	84	13.44	1.29	82	13.38	1.27	166	13.19-13.57	9.50	+	13.32
8-21-50	6,859	medium	12.78	1.47	58	12.78	1.34	47	12.78	1.41	105	12.50-13.05	11.03	-	12.70
8-21-52	9,704	large	16.49	2.15	119	16.31	2.02	72	16.42	2.10	191	16.13-16.72	12.78	+*	16.39
8-21-53	9,206	large	15.81	1.23	76	15.55	1.72	51	15.71	1.44	127	15.45-15.96	9.20	-	15.74
Total	53,670				429			342			771				

[a]Note: skewed right = +; skewed left = -; *significant at .05 level

[b]the first number indicates Agency, the second data 1, the third data 2.

Table 5. Percent tag loss among tagged chinook smolts released from Quinsam hatchery at different sizes and times in 1982.

Release date	Tag code	Size group	Percent tag loss	Length (mm) $\bar{x}$	Length (mm) SD
May 5	8-21-19	small	6.52	56.92	4.05
	8-21-20	small	2.25	59.25	3.48
	8-21-21	small	2.44	58.15	3.42
	8-21-22	medium	2.56	61.31	3.02
	8-21-23	medium	1.74	63.35	2.81
	8-21-24	medium	1.60	65.63	2.51
	8-21-25	large	8.33	67.94	3.24
	8-21-26	large	6.40	67.45	2.82
	8-21-27	large	6.56	69.57	3.00
May 26	8-21-28	small	6.98	77.37	4.56
	8-21-29	small	5.71	77.00	4.27
	8-21-30	small	8.70	78.75	5.96
	8-21-31	medium	1.79	84.51	3.31
	8-21-32	medium	1.53	84.55	2.87
	8-21-33	medium	2.13	84.61	2.35
	8-21-34	large	0.97	89.99	3.20
	8-21-35	large	1.01	89.16	3.13
	8-21-36	large	0.00	90.06	3.28
June 16	8-21-37	small	6.45	89.70	4.41
	8-21-38	small	5.88	87.47	3.60
	8-21-39	small	5.61	86.90	4.43
	8-21-40	medium	2.02	96.25	3.08
	8-21-41	medium	1.71	94.42	3.35
	8-21-42	medium	2.30	92.59	2.80
	8-21-43	large	0.00	99.05	3.46
	8-21-44	large	0.00	101.51	3.11
	8-21-45	large	0.89	97.81	2.97
July 7	8-21-46	small	7.40	95.51	5.00
	8-21-47	small	8.70	94.32	5.67
	8-21-49	medium	1.75	104.31	3.09
	8-21-50	medium	1.84	102.05	3.44
	8-21-52	large	0.00	110.78	4.17
	8-21-53	large	0.00	109.53	3.18

Table 6. Blood sodium levels after 24 h exposure to sea water for three size groups of chinook smolts in each of four releases from Quinsam Hatchery in 1982.

Date released	Date tested	Size group	Observations after challenge: N	Length (cm) $\bar{x}$	Length (cm) S.E.	Blood Sodium (meq/L) $\bar{x}$	Blood Sodium (meq/L) S.E.	Weight (g) $\bar{x}$	Weight (g) S.E.	Condition factor $\bar{x}$	Condition factor S.E.
May 5	May 6	Small	8	5.89	.07	176.6	3.7	1.80	.09	.87	.02
		Medium	11	6.54	.08	163.9	0.9	2.52	.02	.90	.02
		Large	15	7.23	.08	163.5	1.6	3.54	.14	.93	.02
		ALL	36	6.69	.10	166.3	1.4	2.80	.13	.91	.01
May 26	May 29	Small	9	8.03	.22	174.4	2.3	4.71	.33	.91	.01
		Medium	11	8.59	.08	175.8	2.2	5.74	.23	.90	.01
		Large	11	9.04	.15	172.8	1.7	7.22	.38	.96	.01
		ALL	32	8.58	.11	174.2	1.1	5.95	.25	.92	.01
June 16	June 7	Small	6	8.78	.11	173.6	2.5	6.35	.29	.94	.02
		Medium	20	9.43	.04	177.6	2.2	7.74	.11	.92	.01
		Large	10	9.95	.06	183.4	5.3	9.23	.27	.94	.02
		ALL	36	9.47	.07	178.5	2.0	7.92	.19	.93	.01
June 16	June 18	Small	13	9.04	.11	165.7	1.2	7.05	.25	.95	.01
		Medium	8	9.94	.13	166.1	1.7	9.56	.50	.97	.02
		Large	13	10.15	.06	167.6	3.4	10.10	.33	.96	.02
		ALL	36	9.65	.10	167.0	1.4	8.79	.30	.96	.01
July 7	June 29	Small	7	9.30	.28	164.0	2.1	7.70	.71	.94	.01
		Medium	6	10.37	.08	163.9	1.6	10.68	.33	.96	.01
		Large	17	10.99	.10	162.1	0.8	12.99	.42	.98	.01
		ALL	36	10.42	.14	162.9	0.6	11.07	.48	.97	.01
July 7	July 8	Small	15	9.74	.14	161.5	0.7	9.03	.38	.97	.01
		Medium	11	10.92	.09	162.7	0.7	13.00	.47	1.00	.02
		Large	9	11.29	.09	164.7	1.1	15.10	.46	1.04	.01
		ALL	36	10.53	.13	162.7	0.5	11.84	.50	1.00	.01

Notes: No mortality resulted from seawater exposure.
Size groups determined by coded wire tag reading.
Samples taken from release pond 3-5 days before release.
Weight and condition factor may have been affected by dehydration.